TG: @Chalnaayaaar

Current Electricity

SOLUTIONS

BEGINNER'S BOX-1

1. $I = \frac{Q}{t} = \frac{10000\times2\times1.6\times10^{-19}}{60}$

$= 0.5 \times 10^{-16}$ A

2. $I = \frac{Ne}{t} = ne \Rightarrow n = \frac{I}{e} = \frac{3.2\times10^{-3}}{1.6\times10^{-19}} = 2 \times 10^{16}$

3. $v_d = \frac{I}{neA}$

$= \frac{6.25}{8.5\times10^{28}\times1.6\times10^{-19}\times3.14\times(1\times10^{-3})^2}$

$= 0.15$ mm/s

4. $I = \frac{Q}{t} = \frac{90}{4500} = 0.02$ A

$v_d = \frac{I}{nAe}$

$= \frac{0.02}{(5.8\times10^{28}\times10^{+6})(1.6\times10^{-19})\left[\frac{\pi}{4}\times(10^{-3})^2\right]}$

$= 2.74 \times 10^{-12}$ m/s

BEGINNER'S BOX-2

1. Resistance $R = \frac{\rho\ell}{A}$ where $\ell = 100$ m,

$A = 1 \times 1 = 1m^2$

$\therefore R = \frac{4\times10^{-6}\times100}{1} = 4 \times 10^{-4}\ \Omega$

2. $R = \frac{\rho\ell}{A} = \frac{\rho(A\ell)}{A^2} \Rightarrow R \propto \frac{1}{A^2} \propto \frac{1}{r^4}$

$\frac{\Delta R}{R}\times100 = 4 \times \frac{\Delta r}{r}\times100 = 4 \times 0.1 = 0.4\%$

3. $\because$ Resistance $R = \rho\frac{\ell}{A} = \rho\frac{\ell.\ell}{A.\ell} = \rho\frac{\ell^2}{V}$

($\because$ ρ & V are constant)

$R_2 = R_1\left(\frac{\ell_2}{\ell_1}\right)^2 = R_1\left(\frac{2\ell_1}{\ell_1}\right)^2 = 4R_1 = 4 \times 5 = 20\ \Omega$

Resistivity of the wire remains unchanged as it does not change with change in dimensions of a material without change in its temperature.

4. $\because$ $R_\theta = R_0(1 + \alpha\theta)$ where $\alpha = \frac{1}{273}\ ^\circ C^{-1}$

& $R_\theta = 2R_0$

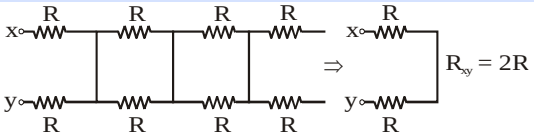
$\Rightarrow 2R_0 = R_0(1 + \alpha\theta) \Rightarrow \theta = \frac{1}{\alpha} = 273^\circ C$

5. (A) – q, (B) – p, (C) – r

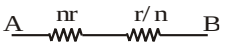
6. (A) – s, (B) – p, (C) – q,t, (D) – r

BEGINNER'S BOX-3

1.



2.



$R_{AB} = nr + r/n$

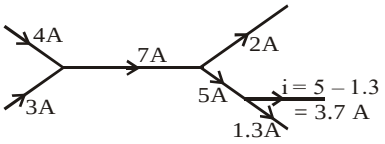
$= \frac{r(n^2+1)}{n}$

3. Connect them in parallel combination

4. $\frac{R_1}{R_2} = \frac{A_2}{A_1} \Rightarrow \frac{R_1}{10} = \frac{3}{1} \Rightarrow R_1 = 30\ \Omega$

$R_{eq} = R_1 + R_2 = 40\ \Omega$

5.



6. $i = \frac{12-8}{12} = \frac{1}{3}$ A

$V_{PQ} = 9 \times \frac{1}{3} = 3$ Volt

BEGINNER'S BOX-4

1. $i = \frac{220-(1.8\times20)}{R+(0.1\times20)} = 15 \Rightarrow R = 10.27\ \Omega$

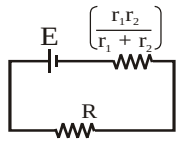
2. When i = 0 V = E = 2 Volts

$r = \frac{E-V}{i} = \frac{2}{5} = 0.4\ \Omega$

3. $i = \frac{8-4}{4.5+0.5+1+2} = 0.5$ A

$E_1 = 4 + (0.5 \times 0.5) = 4.25$ Volts

$E_2 = 8 - (0.5 \times 1) = 7.5$ Volts

4. $\Rightarrow$ 

For max power in R $\Rightarrow$ R = $\frac{r_1r_2}{r_1+r_2}$

5. $\frac{V^2}{R} = P \Rightarrow V = \sqrt{R \times P} = \sqrt{196 \times 1} = 14 \text{ volt}$

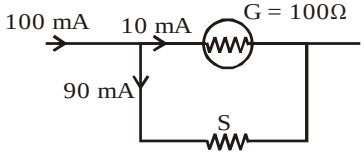
6. Let resistances of bulbs are R and 2R

Power dissipated $P = \frac{V^2}{R}$

$\therefore P_1 = \frac{V^2}{R}$

and $P_2 = \frac{V^2}{2R}$ $\quad \therefore \frac{P_1}{P_2} = \frac{2}{1}$

BEGINNER'S BOX-5

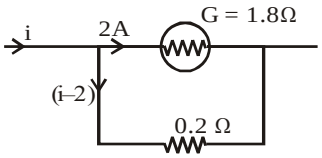
1. 

10 mA × 100Ω = S × 90 mA

S = 11.11 Ω

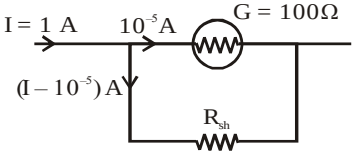
2. S = (n – 1) Ghere n = $\frac{20}{20 \times 0.01} = 100$

S = 99 × 20 = 1980Ω = 1980 Ω

3. 

(i – 2) × 0.2 = 2 × 1.8 $\Rightarrow$ i = 20 A

4. G = 100 Ω, $I_g = 10^{-5}$ A



$10^{-5} \times 100 = (I - 10^{-5})R_{sh}$

$10^{-3} = (1 - 10^{-5})R_{sh} \Rightarrow R_{sh} \approx 10^{-3}\ \Omega$

5. $R_s = \frac{R_g \times i_g}{i - i_g}$

here $i_g = \frac{10}{100} \times i = \frac{i}{10} \Rightarrow R_s = \frac{99 \times \frac{i}{10}}{i - \frac{i}{10}} = 11\ \Omega$

6. The electric current through ideal voltmeter is zero.

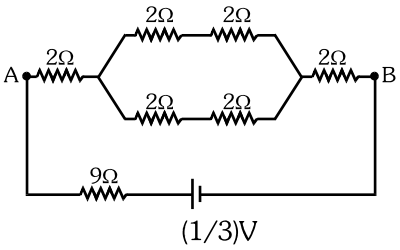
According to loop rule, E –1 × I –1 × I = 0

$\Rightarrow I = \frac{E}{2} = \frac{2}{2} = 1$ A

Reading of the voltmeter = $V_A - V_B$ = [1 × I]

= [1 × 1] = 1 V

7. For maximum power, external resistance is equal to internal resistance. Therefore, 2R = 4 or R =2 Ω

8. (a) 

$R_{net} = 2 + \frac{4 \times 4}{4+4} + 2 + 9 = 15\ \Omega$

(b) Total current flow in circuit = $\frac{1/3}{15} = \frac{1}{45}$ A

Apply KVL

$V_A - 2 \times \frac{1}{45} - 4 \times \frac{1}{2 \times 45} - 2 \times \frac{1}{45} = V_B$

$V_A - V_B = \frac{2}{45} + \frac{2}{45} + \frac{2}{45} = \frac{6}{45} = \frac{2}{15}$

= 0.133 Volts

or

V_{AB} = (I × R from A to B) = $\frac{1}{45} \times (6) = \frac{6}{45}$

$= \frac{2}{15} = 0.133$ V

9. $\because \quad i_1 = \frac{R_2}{R_1 + R_2} i$

Required current = $\frac{(25+5)}{(25+5)+(10+2)} \times 1.4$

$= \left(\frac{30}{42}\right)(1.4) = 1$ A

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10. From the first balance point

$\frac{R}{S}=\frac{40}{100-40}=\frac{40}{60}$.

If 12Ω is connected in parallel with S then

$S_{eq}=\frac{12S}{12+S}$

so from new balance conditions $\frac{R}{S_{eq}}=\frac{64}{36}$

$\Rightarrow \frac{R(S+12)}{12S}=\frac{64}{36} \Rightarrow \left(\frac{40}{60}\right)\left(\frac{S+12}{12}\right)=\frac{64}{36}$

$\Rightarrow S + 12 = 32 \Rightarrow S = 20\Omega$

So $R=\left(\frac{2}{3}\right)(20)=\frac{40}{3}\Omega$

11. (a) Balanced Wheat stone Bridge

$\Rightarrow \frac{P}{Q}=\frac{R}{S}$

(b) From B to D

$\Rightarrow \frac{P}{Q}<\frac{R}{S}$ so $V_B > V_D$

BEGINNER'S BOX-6

1. $E = x\ell_1 = \frac{V}{\ell}\ \ell_1 = \frac{V}{\ell}\left(\frac{\ell}{3}\right)$ ...(1)

ℓ = length of wire

again $E = x'\ell' = \frac{V}{3\ell/2}\ell'$ ...(2)

Divided eq.(1) by (2)

$\ell' = \ell/2$

2. $V_{AB}=\frac{2}{15+10}\times 10$

PG along AB $=\frac{V_{AB}}{1}=\frac{4}{5}$ V/m = 0.8 V/m

Now in secondary ckt

$i=\frac{1.5}{0.3+1.2}=\frac{1.5}{1.5}=14$

$\therefore$ V = 1 × 0.3

Now

V = PG × ℓ

$0.3=\frac{4}{5}\times\ell$

$\frac{1.5}{4}=\ell$; ℓ = 0.375 m = 37.5 cm

3. $\frac{dV}{d\ell}$ will be smaller.

4. $PG=\frac{3}{5+10}\times 10 = 2$ V/m

Now V = P.G. × ℓ

1.2 = 2 × ℓ

ℓ = 0.6 m

5. Current , $I=\frac{3}{10+20}=\frac{1}{10}$ = 0.1 A,

potential gradient $=\frac{V}{\ell}$

$=\frac{0.1\times 20}{10}=0.2$ V / m